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DESCRIPTION

COMPOSITE FABRIC

Technical Field

5   The present invention relates to a composite fabric,
particularly to a fabric that does not change its surface
color when water sticks thereto or the fabric absorbs
water due to the contact of the fabric with water, for
example, wetting of the fabric with water (the fabric
10   being referred to as an "anti-color change fabric"). The
anti-color change fabric of the present invention is
appropriately used for goods in daily use, namely,
applications in which the fabric is wetted with
perspiration and water in addition to applications in
15   clothing such as blouses, shirts, sports shirts, jerseys,
swimwear, spats, trousers, long pants and coats.

Background Art

        When clothing is wetted with rain or perspiration,
20   only portions of the clothing such as shoulders, sides
and back are sometimes discolored, that is, the color of
the portions is deepened, and the surface is discolored.
Moreover, when the bottoms of trousers or long pants are
discolored by splashes of water from puddles or the like,
25   and their excellent appearance is significantly marred.
        When fiber products are wetted with water, the
products tend to become transparent. Japanese Unexamined
Patent Publication (Kokai) Nos. 55-158331 and 5-24265
disclose that a white pigment can be mixed with fibers so
30   that the tendency of the fabric toward becoming
transparent when wetted is diminished. Japanese
Unexamined Patent Publication (Kokai) No. 5-93343
discloses a fabric in which a core-sheath composite fiber
contains a large amount of a white metal oxide in the
35   core portion. These attempts are based on the idea that
the reflectance of light on a fiber surface is increased
by mixing the white metal oxide with the fiber to

decrease the light transmission of the fiber. When clothing colored by dyeing or the like procedure is partly contacted with rainwater, perspiration or the like, water sticks to the clothing to temporarily change the color, and the appearance is sometimes marred.

It is desirable that clothing has a function of preventing and suppressing such a temporary color change of the appearance.

Disclosure of the Invention

An object of the present invention is to provide a fabric that is not easily discolored by the contact and adhesion of water.

The phenomenon of color change (appearance of deep colors) of a fabric at the time when yarns forming the fabric are wetted will be explained. Human eyes detect the combination of surface-reflected light resulting from light reflected on the surface of a material and interior-reflected light resulting from light entering the interior of the material and reflected at an interior boundary. The surface-reflected light is the same as the incident light in that it is white light; the interior-reflected light is colored light that is the light not absorbed by dyes etc. and has a specific wavelength. The deepness of the color is determined by the proportion of the colored light to the white light, and the color appears deeper when the proportion of the white light becomes smaller. The proportion of the white light therein decreases as the refractive index of the material (fiber) surface lowers. Since the refractive index of water (1.33) is smaller than that of a fiber (1.5 to 1.7), the surface of a fiber wetted with water comes to have a low refractive index. As a result, the proportion of the white light decreases, and the fabric appears to be deeply colored.

A fiber containing a large amount of a white pigment is less discolored by water than a fiber containing no

white pigment. However, the color change of a fabric
wetted with water cannot be prevented when a fiber
containing a white pigment is used alone or the fiber is
mixed with another fiber by a conventional procedure such

5   as mixed fiber spinning or combined filament mixing
technique or combining.

        The present inventors understand that the color
change of a fabric at the time when the fabric is
contacted with water such as rainwater and perspiration

10   can be suppressed by the use of a composite fabric
comprising a white pigment-containing fiber that is a
synthetic fiber that contains from 1% by weight or more
to 6% by weight or less of a white pigment and/or a core-
sheath composite fiber comprising a core portion that

15   contains from 3% by weight or more to 15% by weight or
less of a white pigment, and a sheath portion containing
2% by weight or less of a white pigment, and a water-
absorbent and water-diffusing fiber.

        The present inventors have found that a significant

20   anti-color change effect of a fabric can be obtained by
forming the fabric from a white pigment-containing fiber
and a water-absorbent and water-diffusing fiber, and
further texturing a specific structure of the fabric.

        The present invention relates to a fabric comprising

25   the white pigment-containing fiber and the water-
absorbent and water-diffusing fiber, and the fabric is a
composite one in which the white pigment-containing yarn
is in such an arrangement that it uniformly covers the
surface of the fabric at a covering ratio of at least 40%

30   preferably at least 50% to form the fabric structure.

        The covering ratio herein is represented by a
percentage of an area of the exposed white pigment-
containing fiber based on the flat area of the surface of
the fabric. Specifically, the covering ratio is

35   calculated by an image analysis procedure that will be
described later.

        Since a water-absorbent and water-diffusing fiber is

present in the fabric to form a fabric structure in the composite fabric of the present invention, water penetrating the fabric is immediately absorbed and diffused so that localized distribution of water is
5   reduced to zero and the amount of moisture per unit area of the fabric can be immediately reduced. As a result, the color of a portion of the fabric that is contacted with water does not differ from that of the periphery thereof, and the color change of the fabric can be made
10   visually indistinct.

The fabric of the present invention explained above is a knitted or woven fabric of a single layered structure formed by knitting or weaving a yarn composed of white pigment-containing filaments (hereinafter
15   sometimes referred to as a white pigment-containing yarn) and a yarn composed of water-absorbent and water-diffusing filaments (hereinafter sometimes merely referred to as a water-absorbent and water-diffusing yarn) or by knitting or weaving a composite yarn such as
20   a combined filaments yarn or covered yarn of a yarn composed of white pigment-containing yarn and a yarn composed of water-absorbent and water-diffusing yarn. The fabric may be a knitted or woven fabric of a single layer, or a knitted or woven fabric of multi-layers or a
25   multi-layered structure.

For a knitted or woven fabric textured with a white pigment-containing yarn and a water-absorbent and water-diffusing yarn, it is important that the knitted fabric (woven fabric) be made a multi-layered structure knitted
30   fabric (woven fabric) in which the white pigment-containing yarn is arranged on the surface side, so that the surface side of the knitted fabric (woven fabric) is substantially covered by the white pigment-containing yarn. The knitted fabric (woven fabric) may also be
35   prepared by alternately knitting (weaving) the white pigment-containing yarn and the water-absorbent and water-diffusing yarn, or by doubling and knitting

(weaving) them to give a single layered structure knitted fabric (woven fabric), so that the fabric has a structure in which the white pigment-containing yarn covers the surface of the knitted fabric (woven fabric).

Fig. 1 shows a single filament having a W-shaped cross section and forming a typical water-absorbent and water-diffusing fiber.

Fig. 2 is a knitting diagram of a double tuck stitch knit showing one example of a multi-layered structure knitted fabric.

Fig. 3 is a knitting diagram of a urakanoko fabric showing another example of a multi-layered structure knitted fabric.

Fig. 4 is a knitting diagram of a 2-course plain knitted fabric showing one example of a single layered structure knitted fabric.

Best Mode for Carrying Out the Invention

The white pigment-containing fiber and the water-diffusing fiber that form the composite fabric of the present invention will be explained.

As the white pigment-containing fiber, a synthetic fiber that contains from 1% by weight or more to 6% by weight or less of a white pigment and/or a core-sheath composite fiber comprising a core portion that contains from 3% by weight or more to 15% by weight or less of a white pigment and a sheath portion containing 2% by weight or less of a white pigment is used.

There is no specific limitation on the type of the white pigment to be contained in the white pigment-containing fiber of the present invention so long as the white pigment does not hinder the production of the filament yarn.

Preferred examples of the white pigment include metal oxides such as titanium oxide, zinc oxide, magnesium oxide and calcium carbonate. Of these compounds, titanium oxide is most suitable when the cost

is taken into consideration.

It is important that the content of the white pigment in the white pigment-containing fiber as a dull fiber be from 1% by weight or more to 6% by weight or less. The content is desirably from 2% by weight or more to 5% by weight or less. When the content of the white pigment exceeds 6% by weight, the tensile strength of the fiber is significantly lowered. As a result, production of the raw yarn and knitting or weaving of the yarn become difficult, and the yarn may cause wear of the guide or it may form defects such as fluff. Moreover, when the content is less than 1% by weight, a sufficient anti-color change effect is not imparted to the fabric.

For the core-sheath composite fiber, it is important that the content of the white pigment in the core portion be from 3% by weight or more to 15% by weight or less, and the content is desirably from 5% by weight or more to 10% by weight or less. The strength starts to gradually lower when the content of the white pigment in the core portion exceeds 10% by weight, and the tensile significantly lowers when the content becomes 15% by weight or more. Moreover, when the content is less than 3% by weight, a predetermined anti-color change effect cannot be obtained. The core portion and the sheath portion of the core-sheath structure fiber may be formed from the same base polymer or different base polymers. For example, for a polyester core-sheath composite fiber, the sheath portion alone may be formed from a cationic-dye dyeable polymer. Moreover, for a polyamide core-sheath composite fiber, the core portion and the sheath portion may be formed from nylon 66 and nylon 6, respectively. An arbitrary combination of base polymers can be employed. The core and sheath portions may be composed either concentrically or eccentrically. The weight ratio of the core to the sheath is preferably from 1/3 to 3/1, particularly preferably from 1/2 to 2/1. The anti-color change effect becomes insignificant when the

ratio is less than 1/3, and the core component is
sometimes hardly covered with the sheath component during
spinning when the ratio exceeds 3/1.

5   It is desirable from the standpoint of producing the
white pigment-containing fiber that the fiber be produced
by melt spinning a material such as polyamide, polyester
or polypropylene. Although either a raw or flat filament
yarn or a texturized filament yarn of these fibers may be
used, use of a texturized filament yarn having crimps is
10   preferred because a color change becomes indistinct due
to the large cover factor. Moreover, the core-sheath
composite fiber is more excellent in an anti-color change
effect, color developability and processability than the
dull fiber, and is most suited. When polyester thick and
15   thin multi-filaments having a fiber evenness value U of 2
to 8% is used as the core-sheath composite fiber, a
fabric obtained therefrom has a dry feeling and a natural
fiber-like and camouflagic appearance, and shows an
indistinctive color change. Moreover, when the core-
20   sheath composite fiber is subjected to a fluid-jet
texturing process, a fabric obtained therefrom has a spun
yarn-like soft feeling due to the presence of loop fluff.
In addition, the fiber evenness value U is a value
measured with USTER TESTER 3 (manufactured by Zellweger)
25   using a high pass filter, under the following conditions:
a measuring speed of 50 m/min; Measuring Sloot 3; Test
Time 5 min; Tensional Force 1.25%; Pressure 2.5 bar; and
Twist 1,500 s.

The water-absorbent and water-diffusing fiber
30   according to the present invention designates a fiber
having the properties of absorbing and/or diffusing
water.

The "water-absorbent" properties in the present
invention are based on (1) water absorption caused by the
35   water-absorbing properties of the fiber substrate, such
as regenerated cellulose, and (2) a water-retaining
function brought about by the crimping of a single

filament of synthetic fiber formed by a hydrophobic polymer, a fiber form such as a hollow structure and a non-round cross-sectional structure, the surface area effect of a fine fiber and a gap effect on fiber surfaces and filaments.

The "water-diffusing" properties according to the present invention designate the properties of the fiber having significant transferability and diffusibility of water on the surface of the filaments and among filaments caused by the form of the synthetic fiber and the capillary action of a fine fiber. The water-absorbent and water-diffusing fiber used in the present invention may be a short fiber or a long fiber.

The water-absorbent and water-diffusing fiber used in the present invention is determined in the following manner. As explained later, a yarn having a total denier (d) of 100 to 160 d is knitted with a single feeder knitting machine of 28 G to give a plain knitted fabric. The fiber preferably satisfies the following X and Y values obtained from the fabric:

$X \geq 1.6$, $Y \geq 3$

wherein $X = a \times b/100$, and $Y = c/a$ [wherein a is an apparent density = METSUKE (basis of weight)/thickness obtained from the finishing METSUKE (1.5-1.8 $g/100$ cm^2) and thickness (mm) of the fabric, b = a water-retention ratio (%), and c is a water-diffusing area (cm^2) of the fabric].

That is, X is 1.6 or more, more preferably 1.9 or more. As to Y, Y must be 3 or more while the value of X is satisfied. When Y alone is taken into consideration, Y having a larger value tends to make the fiber more water-diffusing. When a fabric formed from two fibers or more is taken into consideration, a fiber having a larger value of X has a greater capacity for incorporating water. Accordingly, for the fabric of the present invention, not just a white pigment-containing fiber

having a large X value but a water-absorbent and water-diffusing fiber having a large X value should be selected.

Since specification of the water absorbability and water diffusibility of a fiber with parameters X and Y represents the water-absorbing and water-diffusing properties of the fiber mass/forming a fabric structure, the specification has an advantage that fibers to be used for an anti-color change fabric can be extremely appropriately carried out in the practical design of the fabric.

When a synthetic fiber is used as the water-absorbent and water-diffusing fiber, a raw yarn and/or a texturized yarn of a modified cross-sectional fiber the filaments of which each have a cross-sectional shape of L, C, W, Z, M, a gear shape or the like, or a raw yarn and/or a texturized yarn of a porous fiber (porosity of 5 to 40%) is employed. In such a case, a raw yarn and/or a texturized yarn having a single filament denier of 2 d or less is employed.

The shape-modification degree of a single filament of a modified cross-sectional fiber is preferably from 1.2 or more to 2.2 or less, more preferably from 1.4 or more to 2.2 or less. When the shape-modification degree is 1.2 or more, the fiber becomes excellent in a balance between water absorbability and water diffusibility compared with a fiber having filaments with a round cross section. When the shape-modification degree exceeds 2.2, the production stability such as spinning stability unpreferably deteriorates. The shape-modification degree herein can be obtained by the following procedure: the cross-sectional area and peripheral length (length of the periphery) of a single filament of a modified fiber are calculated; the radius of a circle having the same cross-sectional area is determined, and the peripheral length of the circle is calculated; the shape-modification degree is obtained from the following formula.

Shape-modification degree = peripheral length of a modified fiber/peripheral length of a circle having the same cross-sectional area as the modified fiber

In order to increase the way or track for passage of water and enhance the water absorbability and water diffusibility, a filament with a W-shaped cross section as shown in Fig. 1 having the following factors are recommended: a shape-modification degree of from 1.4 or more to 2.2 or less, preferably 1.5 or more; and θ_1 to θ_3 of from 60° or more to 160° or less, preferably from 120° or more to 150° or less. Moreover, a fabric in which a W-shaped cross-sectional filament having a single filament denier of 0.3 to 1.5d is used is soft, and a soft feeling can be obtained even when, for example, a woven fabric having a high density is prepared from the filament. Since narrow capillary tubes are formed when the W-shaped cross-sectional filaments are stacked, the capillary action force becomes large, and the fiber diffuses the water that the fiber has retained without displacing the water (without wetting the fiber again). Accordingly, when the fiber is used for sportswear where a large amount of perspiration is produced, the sportswear shows dryness without giving a cool feeling and a clinging feeling, and can have both anti-color change properties and wearing comfortability. Moreover, there is no specific limitation on the content of the white pigment in the water-absorbent and water-diffusing fiber. However, when the content is 0.2% by weight or more, preferably 0.6% by weight or more, more preferably 1% by weight or more, the water-absorbent and water-diffusing fiber itself hardly changes color. The color change of the fabric therefore becomes still more insignificant, and even when a texture that appears largely on the surface side is used, the color change tends to be insignificant.

In general, a synthetic fiber is preferably used as the water-absorbent and water-diffusing fiber for reasons

explained below. Although the synthetic fiber has no water absorbability based on the fiber substrate, the fiber can be made to have water absorbability and water diffusibility by physical factors, namely, water retainability caused by crimps, a capillary tube phenomenon among filaments, effects of a surface area increase caused by shape-modified cross sections, and the like. Moreover, when the raw yarn of the synthetic fiber is crimped to have crimps, a synthetic fiber having remarkable water retainability can be obtained. However, in this case, a low crimping degree, namely, a crimp stretchability of 15% or less, preferably 7 to 10% is recommended. When the crimping degree is high, the space for retaining water increases. However, the water diffusibility conversely lowers and, as a result, the high crimping degree acts negatively on the anti-color change of the fabric. As explained above, a suitable selection of the shape and yarn texturing conditions of a synthetic fiber makes the balance between water absorbability and water diffusibility excellent. Furthermore, when the synthetic fiber is subjected to hydrophilic processing at the stage of a yarn or fabric, the affinity of the fiber for water preferably increases. A cellulosic fiber containing composite yarn with a cellulose fiber and a synthetic fiber may also be used as the water-absorbent and water-diffusing fiber.

The following fibers, the fiber substrates of which have water absorbability, can be used in the form of spun yarns, filamentary fiber yarns and texturized yarns: regenerated cellulose fibers such as viscose rayon and cuprammonium rayon; and natural fibers such as cotton, hemp and wool.

When such a fiber is improved to be dyeable with a disperse dye, the fiber has an advantage that even when the fiber is a composite material with a polyester fiber, it can be dyed with the same dye in one bath. Since such a fiber, the fiber substrate of which shows water

absorption, can absorb even perspiration in vapor form, the fiber does not make one who wears it feel stuffy. Of these fibers, a cotton yarn or a regenerated cellulose filamentary fiber yarn that has a high twisting

5   coefficient and a relatively long single fiber length and that is densely spun can have remarkable water absorbability and water diffusibility, and satisfy the relationship between X and Y described above. For a regenerated cellulose filaments yarn, the yarn having a

10   single filament denier exceeding 10 d shows significant swelling to have a decreased surface area, and the yarn shows poor diffusibility. On the other hand, the yarn having a single filament denier less than 0.5 d unpreferably shows deteriorated physical properties when

15   the yarn absorbs water.

The water absorbability and water diffusibility of a fiber can be evaluated in accordance with the measuring method of the water absorbability and water diffusibility of a yarn composed of an objective fiber, and the fiber

20   can be selected.

(1) Water absorbability Test of Yarn

A yarn to form a multi-layered fabric is subjected to hank winding, and is scoured, dyed and dried under the same conditions as those under which scouring, dyeing and

25   drying steps are conducted during the production of the desired multi-layered fabric to give a sample yarn. However, when the yarn to be used is a filament yarn, single yarns each having the same single yarn denier as that of the filament yarn to be used in examples and

30   comparative examples are bundled to have a total denier of 75 d ± 5d; a yarn for testing is thus prepared. The yarn is subjected to twisting at 300 T/m, set with steam at 100°C for 15 min, dried, and allowed to stand at 20°C in an RH of 65% for a day to give a sample yarn. When a

35   yarn to be used is a spun yarn, a yarn having a thickness and a twist corresponding to a twisted cotton yarn 10s having such a number of twisting per meter that the

cotton yarn has a twisting coefficient, shown by the
following formula, of 120, is prepared by doubling to
give a sample yarn:

$$T = \alpha \times \sqrt{N}$$

5   wherein T is a number of twists per meter, N is a cotton
count, and α is a coefficient of twists.

A sample 50 cm long for measurement is prepared by
cutting the sample yarn thus prepared. The upper end of
the sample is fixed, and a load of 0.1 g/d is applied to

10   the lower end; the lower end is immersed in water (room
temperature), and the vertical distance of water
absorption is measured after 10 minutes. The water
absorption of the yarn is evaluated by an average value
obtained from the 10 samples. When the water absorption

15   distance is 2 cm or more, the water absorbability is
evaluated to be good.

(2) Water Diffusibility Test of Yarn

Using the same yarn as the sample yarn used in
measuring the water absorbability, the water

20   diffusibility is measured. A yarn 1 m long is cut from
the sample yarn; one end of the yarn is fixed, and a
portion close to the other end is hooked over a pulley,
and the yarn is horizontally tensioned by applying a load
of 0.1 g/d to the end. Onto a portion near the central

25   portion of the yarn under tension, 0.01 ml of water is
added, and the moving distance in the horizontal
direction of water is measured after 10 minutes. The
measurements are made at 20°C with 65% RH, and the water
diffusibility is evaluated by an average value of the

30   measurements made on 10 pieces of the yarn. When the
moving distance of water is 10 cm or more, the water
diffusibility of the yarn is evaluated to be good.

A fiber showing a water absorption of 2 cm or more
and a water diffusion of 10 cm or more determined by the

35   measuring methods described above is preferably used.

In the present invention, the composite fabric is

obtained in the form of a knitted or a woven fabric formed with a white pigment-containing yarn and a water-diffusing yarn; the knitted fabric (woven fabric) must have a textured structure wherein the white pigment-

5 containing yarn covers 40% or more, preferably 50% or more of the surface area of the knitted fabric (woven fabric) when viewed from the surface side thereof.

A knitted fabric (woven fabric) in which 40% or more of the surface side of the knitted fabric (woven fabric)

10 is covered with a white pigment-containing yarn can be formed with a single layer or double layers with respect to the textured structure.

When the knitted fabric (woven fabric) is in a single layer, the fabric must be formed with a knitted

15 fabric (woven fabric) texture in which the white pigment-containing yarn and the water-absorbent and water-diffusing yarn are randomly and uniformly distributed on the surface of the fabric and cover the surface.

When the composite fabric is textured with a multi-

20 layered structure, the surface side layer of the knitted fabric (woven fabric) is knitted (woven) with the white pigment-containing yarn, and the lower layers are knitted (woven) with a knitted (woven) texture that forms the water-absorbent and water-diffusing yarn layers

25 An embodiment wherein the composite fabric of the present invention is a multi-layered structure fabric will be explained.

The structure of the fabric preferably has a multi-layered structure having two layers or more. A multi-

30 layered fabric designates a structure in which two types or more of textures are stacked in layers in appearance to form one fabric. Of a plurality of the layers, the side that becomes a top surface when one wears the fabric is defined as a surface layer, and the layers other than

35 the surface layer are defined as inner layers. Of inner layers, the layer that is closest to the skin and that is contacted therewith is defined as a back layer. The

multi-layered form may either be a woven fabric or a knitted one. For example, in order to obtain a woven fabric having two layers or more, a method such as that explained below should be employed: a method wherein a white pigment-containing fiber is arranged to occupy most of the surface layer by means such as warp backed weave, weft backed weave or triple weave, and a water-absorbable and water-diffusing fiber is used in the layers other than the surface layer. A multi-layered knitted fabric having two layers or more can be formed with a weft knitted fabric or a warp knitted one. As to a weft knitted fabric, a plural layered knitted fabric can be knitted using a double knitting machine. However, the following procedure may also be employed: a bind-weave layer is provided by a texture and yarn use to count as one layer; and the surface layer, the back layer and the bind-weave layer in total can be taken as a knitted fabric having three layers or more. For example, when a three-layered knitted fabric is to be prepared, a double tuck texture as shown in Fig. 2 is employed using a double knitting machine, and a knitted fabric in which a white pigment-containing fiber occupies 90% or more of the surface layer of the fabric is formed by the following feeding of yarns: white pigment-containing yarns at yarn feeders 2, 5; and water-absorbent and water-diffusing yarns and/or other yarns at yarn feeders 1, 4, 3, 6.

A weft knitted fabric having three layers or more can also be prepared by using a texture obtainable by using plaiting technique, and changing the yarn feeding tension of two types or more of yarns. Moreover, even for a one-layered knitted fabric such as a tubular knitted fabric knitted by a weft knitting machine, a tuck can be applied to a specific stitch to impart a partial upheaval to the knitted fabric and to make the fabric in two layers in appearance, or a weft knitted fabric having two layers or more can be formed by plaiting.

Specifically, using a texture of a urakanoko fabric as shown in Fig. 3, feeding white pigment-containing yarns at yarn feeders 1, 3 and feeding water-absorbent and water-diffusing yarns at yarn feeders 2, 4 give a knitted
5   fabric in which the white pigment-containing fiber occupies 80% or more of the surface layer. A reversible texture in which the top surface and the back surface have the same appearance is also a fabric having a multi-layered structure. For a warp knitted fabric, knitting
10   in multi-layers such as two, three or four layers can be conducted by increasing the number of bars.

These textures for a woven fabric or a knitted fabric may optionally be employed in accordance with the applications. The white pigment-containing fiber should
15   occupy the surface layer of the fabric in an area of preferably 50% or more, more preferably 60% or more. Moreover, the white pigment-containing fiber should occupy 1/4 or more, preferably 1/3 or more of the thickness of the transverse cross section of fabric. The
20   water-absorbent and water-diffusing fiber should form one layer or more in the inner layers, namely, layers other than the surface layer for the following reasons. Positive absorption and diffusion of perspiration, from the skin or water splashed on the surface layer, not by
25   the surface layer but by the inner layers composed of the water-absorbent and water-diffusing yarns, can make color change of the surface layer that is composed of white pigment-containing yarns indistinct. When the proportion of coverage of the white pigment-containing fiber in the
30   surface layer is high, the effect becomes significant. That is, the separate presence of the anti-color change layers and the water-absorbent and water-diffusing layers can make the former layers and the latter layers share their respective roles, and the anti-color change effects
35   become excellent.

Fibers other than the white pigment-containing fiber and the water-absorbent and water-diffusing fiber may be

mixed in the multi-layered fabric. For a multi-layered
fabric in which white pigment-containing fiber is
arranged in the surface layer, the preferred mixing
ratios are as follows.   The fabric contains from 30% by
weight or more to 70% by weight or less, more preferably
from 40% by weight or more to 60% by weight or less of
the white pigment-containing fiber; the fabric contains
from 30% by weight or more to 70% by weight or less, more
preferably from 40% by weight or more to 60% by weight or
less of the water-absorbent and water-diffusing fiber
arranged in the inner layers; and the fabric contains 40%
by weight or less, preferably 20% by weight or less of
optional fiber.

When elastic yarns such as spandex yarns are used in
combination by mixing, an elastic knitted fabric the
surface of which is covered with a white pigment-
containing fiber layer can be easily prepared by
plaiting, union knit cloth knitting or the like
procedure.

The knitted fabric the surface of which is covered
with a white pigment-containing fiber as explained above
can be obtained in the following manner: using a plaiting
procedure, a white pigment-containing yarn and a water-
absorbent and water-diffusing yarn are doubled together
with a bare elastomeric yarn or a covered elastic yarn
and knitted with a tubular knitting machine or a sock
knitting machine to give a plain knitted fabric, a tuck
float circular rib fabric, a circular rib fabric, an
interlock fabric or a seamless knitted fabric. In warp
knitting, a warp knitted fabric showing a high covering
ratio of a white pigment-containing fiber can be prepared
by a knitting method wherein a covered elastic yarn
covered with a white pigment-containing fiber is
inserted, or union knit cloth knitting with multi-bars is
conducted (by half knitting, back half knitting, power
net knitting, satin knitting or the like).

When the white pigment-containing yarn is a core-

sheath composite yarn, a stretch knit obtained by
knitting using an elastic yarn such as a spandex yarn so
that the product of a content of the white pigment in the
core portion and a weft density becomes from 150 to
5   1,000, preferably from 300 to 700 not only shows anti-
color change effects but also has a soft feeling and
drapability. Examples of the stretch knit include a
three-bar 2-way tricot in which a white pigment-
containing yarn, a water-absorbent and water-diffusing
10   yarn and a spandex yarn are arranged in a front bar, a
middle bar and a back bar, respectively (mixing ratios
being 40, 40 and 20% by weight, respectively). For such
a tricot fabric, the white pigment-containing yarn in the
knitted fabric covers 90% or more of the surface.
15   Next, an embodiment in which the composite fabric of
the present invention is a single layered structure
fabric textured with a white pigment-containing yarn and
a water-absorbent and water-diffusing yarn will be
explained.
20   A thin and lightweight fabric can be formed from a
single layered structure in comparison with a fabric
formed from a multi-layered structure, and is suited to
sports shirts etc. The term single layer signifies that
the form of the fabric is one layer. The texture of the
25   fabric can be freely selected so long as the fabric is a
woven or knitted fabric in which a white pigment-
containing fiber and a water-absorbent and water-
diffusing fiber randomly appear on the fabric surface.
However, in order to uniformly diffuse water in the
30   fabric without retarding the diffusion of water, it is
necessary that one type of a fiber alone should not
gather in one portion in the fabric, that is, it is
necessary that the fiber should not be used continuously
over a width of 3 mm or more in the warp and/or weft
35   direction in the fabric. The surface area of the fabric
covered by the white pigment-containing fiber should be
40% or more. That of the fabric occupied by the water-

absorbent and water-diffusing fiber should preferably be from 40 to 50%. When the white pigment-containing fiber and the water-absorbent and water-diffusing fiber are adjacent to each other as explained above, water in the

5 fabric moves to the water-absorbent and water-diffusing fiber having a high X value, namely, high water absorption effects to be positively diffused. As a result, the color change becomes indistinct. Since a single layered fabric is thinner and lighter than a

10 multi-layered fabric, it diffuses water and dries quickly. As a result, the single layered fabric has the effect of making the color change disappear rapidly. Usable examples of the texture of a woven fabric include a plain weave texture, a twill weave texture, a satin

15 weave texture or modified texture of these weave textures, which are obtained using a white pigment-containing yarn and a water-absorbent and water-diffusing yarn (one alternate warp yarn, one alternate weft yarn and one alternate warp and weft yarn). When the fabric

20 is a knitted one, a 2-course plain knitted fabric etc. can be made to have a texture of one-layered structure by feeding a white pigment-containing yarn and a water-absorbent and water-diffusing yarn to a yarn feeder of a single knitting machine alternately at intervals of one

25 or two yarns; even a commonly used texture such as an interlock fabric and a Kanoko fabric can be made to have a one-layered structure by uniformly mixing two or more types of yarns in the one-layered knitting structure while the yarn arrangement is taken into consideration.

30 For example, a single layered fabric in which a white pigment-containing yarn and a water-absorbent and water-diffusing yarn appears every one stitch, zigzag and randomly can be prepared by the following procedure: a 2-course plain knitted fabric as shown in Fig. 4 is

35 employed, and alternate feeding of the white pigment-containing yarns at yarn feeders 1, 4 and the water-absorbent and water-diffusing yarns at yarn feeders 2, 3

is conducted. The area occupied by the white pigment-containing fiber on the fabric surface and that occupied by the water-absorbent and water-diffusing fiber thereon are each close to 50%.

5   Other yarns may also be mixed with the white pigment-containing yarns and the water-absorbent and water-diffusing yarns in the single layered fabric. Preferred mixing ratios are as follows: from 40% by weight or more to 60% by weight or less for the white

10   pigment-containing fiber; from 40% by weight or more to 60% by weight or less for the water-absorbent and water-diffusing fiber; and 20% by weight or less for the optional fiber.

       Embodiments of the composite fabric of the present

15   invention that is a knitted or woven fabric in which a composite yarn comprising a white pigment-containing yarn and a water-absorbent and water-diffusing yarn are textured will be explained.

       Since the yarn itself has anti-color change effects

20   in the fabric in which a composite yarn is used, the fabric has an advantage that a thin, lightweight and arbitrary knitted texture can be selected.

       The composite yarn can be prepared by a conventional yarn texturing such as false twisting, elongation

25   difference false twisting, union twisting, union twisting subsequent to false twisting, covering, air mixing combined with Taslan process or interlacing etc., interlaced false twisting, post-interlaced false twist texturizing, spinning and fine spinning and union

30   twisting such as silo file and silo span.

       The structure of a preferred composite yarn is a yarn having a multi-layered structure (two or more layers) in which the white pigment-containing fiber of the outer layer has a large cover factor for the water-

35   absorbent and water-diffusing fiber of the core layer. When a fabric is knitted or woven with the composite yarn of the multi-layered structure, the anti-color change of

the fabric at a level comparable to that of the fabric formed by mixing or combining on a machine explained above can be obtained by positively absorbing and diffusing perspiration and water with the water-absorbent

5   and water-diffusing fiber that does not form the outermost layer but forms the core layer. The multi-layer of the composite yarn designates a state in which the outermost layer occupying the outer periphery of the cross section of the yarn is entangled in or wound around

10   the inner core layer. The core layer designates a fiber layer arranged inside the yarn, and it may be formed from one type of fiber or two or more types of fiber in layers. A multi-layered structure yarn can be obtained by carrying out a method such as composite false

15   twisting, air filaments combining mixing, fluid-jet texturing, union twisting or covering while a white pigment-containing fiber is arranged in the outer layer and procedures such as described below are selected or combined: the yarn used in the outer layer is made

20   thicker than the yarn used in the core layer; the degree of crimping of the outer layer yarn is increased; and a difference in yarn length is made between the yarn in the outer layer and that in the core layer. For the multi-layered structure yarn obtained by such a method, the

25   color change of the yarn becomes more indistinct when the white pigment-containing fiber used in the outer layer covers 60% or more, more preferably 70% or more of the surface area. Specifically, when a union twisted yarn is prepared by using a highly crimped yarn of 75 d having a

30   crimp stretchability of 20% as an outer layer and a raw yarn of 50 d as a core layer, and twisting both yarns with 300 T/M, the yarn in the outer layer covers 70% or more of the surface area of the union twisted yarn. A preferred combining ratio of the white pigment-containing

35   fiber and the water-absorbent and water-diffusing fiber in the multi-layered structure yarn is as follows: from 30% by weight or more to 70% by weight or less, more

preferably from 40% by weight or more to 60% by weight or less of the white pigment-containing fiber of the outer layer; from 30% by weight or more to 70% by weight or less, more preferably from 40% by weight or more to 60% by weight or less of the water-absorbent and water-diffusing fiber of the core layer. Moreover, the mixing ratio of optional fiber to be mixed should be 20% by weight or less.

A covered elastic yarn in which a white pigment-containing fiber and a water-absorbent and water-diffusing fiber are used as a covering fiber (or yarns) is a composite yarn on which the white pigment-containing fiber has a large surface covering ratio. A covered elastic yarn can be prepared by covering a core yarn of an ester- or ether-based polyurethane elastic yarn or polyether ester-based elastic yarn (10 to 15 denier) with a white pigment-containing fiber and a water-absorbent and water-diffusing fiber by single covering, double covering, covering by fluid injection or a core yarn spinning method (CSY). An elastic yarn according to single covering or double covering can be prepared by supplying an elastic yarn at a draft ratio of about 2.0 to 3.5 and twisting with a covering twisting number of 300 to 2,000 T/m.

A three-layered structure yarn or the like in which an elastic fiber situated in the core layer, a water-absorbent and water-diffusing fiber situated on the elastic fiber and a white pigment-containing fiber covering the outermost layer becomes a yarn having an anti-color change effect and suited to clothing requiring stretchability and fitness.

The composite yarn may have a single layered structure. Since a single layered yarn dries significantly quickly, it has an effect of rapidly canceling a color change. The single layer of a composite yarn designates a state in which a white pigment-containing fiber and a water-absorbent and water-

diffusing fiber each appear on the yarn surface in approximately the same proportion. The white pigment-containing fiber should cover from 40% or more to 60% or less, more preferably from 50% or more to 60% or less of

5 the surface area of the composite yarn. As to the mixing manner, the white pigment-containing fiber and the water-absorbent and water-diffusing fiber may be randomly mixed. Alternatively, a collecting unit of a white pigment-containing fiber and a collecting unit of a

10 water-absorbent and water-diffusing fiber may also be alternately arranged, for example, side-by-side. When a white pigment-containing fiber and a water-absorbent and water-diffusing fiber are randomly mixed, incorporation of water between a single yarn of the white pigment-

15 containing fiber and a single yarn of the water-absorbent and water-diffusing fiber takes place, and water is moved to the water-absorbent and water-diffusing fiber that has a high X value, namely, a high water absorbing effect, whereby water is positively diffused. As a result, the

20 color change becomes indistinct. When both fibers are mixed in certain collecting units, for example, side-by-side, incorporation of water takes place between a collecting unit of the white pigment-containing fiber and a collecting unit of the water-absorbent and water-

25 diffusing fiber. The water is moved to the water-absorbent and water-diffusing fiber and is also diffused in this case. The color change becomes indistinct in both cases. However, the effect is more noticeable in the case of the fibers being arranged side by side, in

30 which case the water absorbing force and the water-diffusing force are gathered. Such a method, as explained below, is used for obtaining the composite yarn having a single layered structure: a white pigment-containing yarn and a water-absorbent and water-diffusing

35 raw yarn both having the same total denier are union twisted or air combined without a difference in the yarn length. Specifically, a single layered structure yarn

prepared by interlace combining a white pigment-containing yarn and a water-absorbent and water-diffusing yarn both having a total denier of 75 d without a difference in the yarn length contains both yarns in a

5 randomly mixed manner; both fibers each cover the surface in approximately the same proportion. A preferred mixing ratio of the white pigment-containing fiber and the water-absorbent and water-diffusing fiber should be as follows: from 40% by weight or more to 60% by weight or

10 less for the white pigment-containing fiber; from 40% by weight or more to 60% by weight or less for the water-absorbent and water-diffusing fiber; and 20% by weight or less for an optional fiber to be mixed. Since the single layered structure yarn has a moiré tone and a natural

15 fiber-like appearance after dyeing, it has wide applications.

These two compositing methods, namely, compositing on a machine and compositing with yarn can be used in combination. For example, there are such methods as

20 explained below: a composite yarn having a multi-layered structure is used in the surface layer and/or the back layer of a fabric having a multi-layered structure; and a composite yarn having a single layered structure is similarly used in the back layer. The single layered

25 structure knitted fabric or the composite structure knitted fabric in which a white pigment-containing fiber occupies 50% or more of the top surface area of the fabric shown in Examples 22 to 24 can be obtained by such methods so long as the white pigment-containing fiber

30 appears or covers 50% or more of the surface area of the yarn.

The size of a yarn that forms the fabric of the present invention is arbitrarily selected in a conventionally used region of the yarn in a woven or

35 knitted fabric for ordinary clothing. For a filament yarn, the size is preferably from 30 to 300 d. For a spun yarn, the size is preferably from 20 to 80 s (cotton

count). However, the size is not restricted to those described above.

Moreover, a water-absorbing agent should be imparted to a fabric in the dyeing or finishing step. Imparting a water-absorbing agent, as explained above, particularly improves the affinity of a synthetic fiber for water, and the water diffusibility level of the fabric as a whole is increased. As a result, the color-change degree becomes still smaller. For example, such a water-absorbing agent or a hydrophilic agent mainly containing a hydrophilic copolymer such as the SR series manufactured by Takamatsu Yushi K.K. or Fine Set F 101 (trade name, manufactured by Senka K.K.) should be imparted in an amount of 3 to 5% owf. During the imparting, a finishing treatment, that makes the resistance of the water-absorbing agent to repeated washing and long term wear excellent, is preferably conducted because the anti-color change effects can then be maintained over a long period of time.

When compared with conventional fabrics, the fabric of the present invention shows an anti-color change effect that is sometimes significant and that is sometimes slightly insignificant depending on the color in which the fabric is dyed. The colors for which the effect is considerable range from a pale to a medium deep color of various colors such as blue, green, red, yellow, orange, purple and gray. The colors for which the effect is slightly insignificant range from a deep to an extremely deep color of various colors, and white and black are also included therein.

Methods of measuring the properties of the composite fabric and the fiber of the present invention, methods of evaluating the fabric and methods of measuring the covering ratio in the present specification are as described below.

[1] Crimp Stretchability

The crimp stretchability is measured in accordance

with 5.7 [Stretch Method B] in the Testing Method of a
Bulky Textured Yarn of a Synthetic Fiber (JIS-L-1090).
[2] X and Y Values Related to Water-Absorbent and Water-
     Diffusing Fiber

5   A yarn having a total denier of 100 to 160d is used.
A plain knitted fabric is prepared from the yarn using a
knitting machine of 28 G having a single yarn feeder.
The fabric is successively scoured, subjected to water
absorption processing, and is finally set. The fabric

10 thus finished is moisture conditioned for a day in a
thermostatic chamber (having a temperature of 20°C and a
humidity of 65%). The fabric is made to have finish
METSUKE of 1.5 to 1.8 (g/100 cm^2). The knitted fabric
thus obtained is cut to give a sample having a size of 10

15 cm × 10 cm. The following were measured in the
thermostatic chamber.
        (i)   METSUKE (basis of weight)
        The METSUKE is an average weight of the three
samples having an area of 100 cm^2 (g/100 cm^2).

20   (ii) Thickness
        The thickness of five such samples is measured
at a contact pressure of 5 g/cm^2. An average value of
the thickness at 10 freely selected points in total of
the five samples, is defined as the thickness.

25   (iii) Water-Retention Ratio
        The sample having a size of 10 cm × 10 cm and
having been used for measuring the weight is immersed in
ion-exchanged water for 5 minutes, and centrifugally
dehydrated under the condition of 1,000 rpm × 1 min. The

30 sample weight is immediately measured after dehydration,
and the water-retention ratio is calculated by the
formula:
        water-retention ratio = ([weight after
dehydration/initial weight] - 1) × 100

35   (iv) Water Diffusion Area
        A micropipette was used, and the tip end

thereof was put 2 cm away from the surface of the sample having a size of 10 cm × 10 cm. On the sample, 0.1 ml of a solution prepared by diluting 0.1 mg of a dye (trade name of Diacid Alizarin Light Blue 4GL, manufactured by

5   Dye Star K.K.) with 100 ml of ion-exchanged water is dropped. The diffusion area (cm^2) of the diluted solution is measured from the surface 2 minutes after dropping the solution. The measurements are made on three samples, and an average value obtained from the

10   three samples is defined as the water dispersion area.

In addition, the diluted solution of a dye is prepared from a dye having a low molecular weight and being readily soluble in water.

Using the values obtained in (i) to (iv), X and Y

15   are defined as follows and the values are calculated:

$X = a \times b/100$, and $Y = c/a$

wherein a is an apparent density = METSUKE (g/100 cm^2)/thickness (mm), b = water-retention ratio (%), and c is a diffusion area (cm^2). The following X and Y values

20   are preferred because the fabric shows excellent water absorbability and water diffusibility:

$X \geq 1.6$ and $Y \geq 3$

The water absorbability and water diffusibility of a yarn to be used for machine compositing or yarn

25   compositing is evaluated on samples prepared by plain knitting the yarn with a single feeder knitting machine. For example, the evaluation is conducted on the plain knitted fabric of a crimped yarn when the crimped yarn is to be used for machine compositing or yarn compositing,

30   and the plain knitted fabric of a raw yarn when the raw yarn is to be employed.

In addition, the conditions of scouring, dyeing, water absorption processing and final setting (setting for smoothing out creases) are as follows.

35   Scouring:

a bath ratio of 1:20; temperature × time of 80°C ×

20 min; and a scouring agent (trade name Scourol, manufactured by Kao Corporation) in an amount 2 g/l.

Water absorption processing:

a bath ratio of 1:20; a water absorption processing agent (trade name of SR-1000, manufactured by Takamatsu Yushi K.K.) in an amount of 5% owf; and temperature × time of 95°C × 30 min.

Final setting:

180°C × 0.5 min.

[3] Evaluation of Anti-Color Change of Fabric

A numerical evaluation with a colorimeter and an organoleptic evaluation explained below are carried out in combination.

(A) Measurement with Colorimeter of Color Difference

($\Delta E*$) Expressed by Numerical Value

Measurements are made with a colorimeter (trade name Macbeth Color Eye 3000, manufactured by Sakata Inks. K.K.).

(i) A dried fabric having a size of 20 cm × 20 cm is folded double, and applied to the color-measuring portion having a diameter of 2.5 cm of the colorimeter; a light source C is used, and sensory color index numbers a*, b* and a brightness L* are obtained. The values thus obtained are defined as standard sensory color index numbers and a standard brightness, respectively.

(ii) To a sample, .1 ml of water is applied. The wet portion where water has diffused is similarly measured after 30 sec, and sensory color index numbers a*, b* and a brightness L* are obtained. The values thus obtained are defined as trial sensory color index numbers and a trial brightness, respectively.

(iii) The standard values of the sensory color index numbers a*, b* and the brightness L* and the trial values thereof are substituted into the following formula, and the color difference $\Delta E*$ is calculated:

$$\Delta E^* = \{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\}^{1/2}$$

(B) Organoleptic Evaluation

The organoleptic values of a color-change obtained by visual inspection by 10 inspectors are classified in accordance with the organoleptic evaluation criteria explained below, and the average value is obtained. Specifically, a sample having a size of 20 cm × 20 cm is prepared. On an approximately central portion thereof, 1 ml of water is dropped with a pipette, and the portion colored by dropping water 30 sec after dropping and a region peripheral to the colored portion are compared. The evaluation results are arranged in the order of increasing color change:

◎↑ no difference in color is observed between a dried portion and a wet portion;

◎ substantially no difference in color is observed between a dried portion and a wet portion;

○ difference in color is observed to a lesser extent between a dried portion and a wet portion;

Δ difference in color is slightly observed between a dried portion and a wet portion, and the color change is distinctive when clothing is assumed; and

X difference in color is significantly observed between a dried portion and a wet portion, and the color change is very distinctive when clothing is assumed.

When the difference in color between a dried portion and a wet portion is large, one has an unpleasant feeling during an organoleptic test. A preferred difference in color is as follows: $\Delta E^* \le 5$.

[4] Image Analysis of the Surface of a Fabric (or a Yarn)

The surface of the textile to be image analyzed, of a fabric, or the side surface to be image analyzed, of a yarn, is magnified by a factor suitable for the analysis, and the magnified surface or side surface is photographed. The photograph is made into an image, and the image is observed and processed as explained below. Data for white pigment-containing yarns appearing on the surface of the knitted fabric and yarns other than the white pigment-containing yarns are separately processed, and the data for white pigment-containing yarns alone are selected. The covering ratio (%), namely, the ratio of the area of the white pigment-containing yarns to the entire area is calculated by image analysis.

Examples of the present invention will be explained below. However, the scope of the present invention is in no way restricted by the explanation.

In addition, the texturing conditions and dyeing conditions of fibers and yarns used for the preparation of fabrics in examples are as described below.

[1] Yarns Having a W-Shaped Modified Cross Section

Polyester filaments yarns (75 d/30 f, 75 d/60 f, 50 d/30 f) having a W-shaped cross section and a shape-modification degree of 1.55 were used.

[2] Methods and Conditions of Processing Yarns for Knitted or Woven Fabrics in Examples

(i) Texturing Condition 1: False Twisting

Using an LS-2 manufactured by Mitsubishi Heavy Industries Ltd., a false-twisted yarn having a crimp stretchability of 18 to 22% was obtained under the following conditions: a number of twisting of Z-3200 T/M for a yarn of 75 d, and Z-2400 T/M for a yarn of 150 d; a first heater temperature of 210°C, and a second heater temperature of 180°C; an overfeeding ratio of 13%; and DR = 1.04.

(ii) Texturing Condition 2: False Twisting

Using an LS-2 manufactured by Mitsubishi Heavy

Industries Ltd., a false-twisted yarn having a crimp
stretchability of 7 to 15% was obtained by false twisting
under the following conditions: a number of twisting of
Z-3200 T/M for a yarn of 75 d, and Z-2400 T/M for a yarn
5   of 150 d; a first heater temperature of 190°C, and a
second heater temperature of 180°C; an overfeeding ratio
of 6.5%; and DR = 1.04.

      (iii)   Texturing Condition 3: False Twisting

          Using an LS-2 manufactured by Mitsubishi Heavy
10   Industries Ltd., a false-twisted yarn having a crimp
stretchability of 18 to 22% was obtained by false
twisting under the following conditions: a number of
twisting of Z-2400 T/M; a first heater temperature of
180°C, and a second heater temperature of 170°C; an
15   overfeeding ratio of 13%; and DR = 1.04.

      (iv)   Texturing Condition 4: Doubling and Twisting

          Using a DTB twisting machine manufactured by
Ishikawa Seisakusho, Ltd., a twisted yarn with a twisting
direction of S and a twisting number of 300 T/M was
20   obtained at a yarn-processing rate of 20 m/min.

      (v)   Texturing Condition 5: Composite False Twisting
            and Interlaced False Twisting

          Using a 33H false twisting machine manufactured
by Murata Kikai K.K., the feed ratio of a yarn (50 d) for
25   the core layer and that of a yarn (75 d) for the outer
layer were set at 1.5% and 4%, respectively, and the
yarns were interlaced at an air pressure of 2 kg/cm^2.
False twisting was then conducted under the following
conditions: DR = 1.04; a processing rate of 400 m/min; a
30   twisting number of Z-2600 T/M; and a heater temperature
of 180°C.

      (vi)   Texturing Condition 6: Composite False Twisting
            and Taslan False Twisting

          Using a 33H false twisting machine manufactured
35   by Murata Kikai K.K., the feed ratio of a yarn (50 d) for
the core layer and that of a yarn (75 d) for the outer
layer were set at 5% and 15%, respectively, and the yarns

were Taslan processed at an air pressure of 7 kg/cm². False twisting was then conducted under the following conditions: DR = 1.04; a processing rate of 400 m/min; a twisting number of Z-2600 T/M; and a heater temperature of 180°C.

(vii) Texturing Condition 7: Interlacing

Using a 33H false twisting machine manufactured by Murata Kikai K.K., the feed ratio of a yarn (50 d) for the core layer and that of a yarn (75 d) for the outer layer were set at 1.5% and 4%, respectively, and the yarns were interlaced at an air pressure of 2 kg/cm².

(viii) Texturing Condition 8: Taslan Processing

Using a 33H false twisting machine manufactured by Murata Kikai K.K., the feed ratio of a yarn (50 d) for the core layer and that of a yarn (75 d) for the outer layer were set at 5% and 15%, respectively, and the yarns were Taslan processed at an air pressure of 7 kg/cm².

(ix) Texturing Condition 9: Covering

Using a single covering machine, a yarn (50 d) for the core layer fed at a rate of 100 m/min was covered with a yarn (75 d) for the outer layer at a twisting number of Z-1,500 T/M while the spindle was rotated at 15,000 rpm.

(x) Texturing Condition 10: Interlaced False Twisting

Using a 33H false twisting machine manufactured by Murata Kikai K.K., both yarns (75 d) were interlaced at a feed ratio of 1.5% and an air pressure of 2 kg/cm². False twisting was then conducted under the following conditions: DR = 1.04; a processing rate of 400 m/min; a twisting number of Z-2400 T/M; and a heater temperature of 180°C.

(xi) Texturing Condition 11: Interlace False Twisting

Using a 33H false twisting machine manufactured by Murata Kikai K.K., both yarns (75 d) were interlaced at a feed ratio of 10% and an air pressure of 7 kg/cm².

False twisting was then conducted under the following conditions: DR = 1.04; a processing rate of 400 m/min; a twisting number of Z-2400 T/M; and a heater temperature of 180°C.

(xii)   Texturing Condition 12: Interlacing
Using a 33H false twisting machine manufactured by Murata Kikai K.K., both yarns (75 d) were interlaced at a feed ratio of 1.5% and an air pressure of 2 kg/cm^2.

(xiii)   Texturing Condition 13: Taslan Processing
Using a 33H false twisting machine manufactured by Murata Kikai K.K., both yarns (75 d) were Taslan processed at a feed ratio of 10% and an air pressure of 7 kg/cm^2.

[3] Method of Dyeing a Fabric
(i)   Dyeing Method 1: Dyeing a Composite Fabric of Polyester-Cellulose

Scouring
Bath ratio   1:20
Temperature × time   80°C × 20 min
Scouring agent   Scourol (trade name, manufactured by Kao Corporation) 2 g/l.

Dyeing a Polyester Fiber:
Dye: Dianix Blue UN-SE (manufactured by Dye Star K.K.) 1.0% owf
Bath ratio   1:40
Temperature × time   130°C × 30 min
                     pH5 buffer CH_3COOH, CH_3COONa

Soaping:
Bath ratio   1:20
Soaping agent   Sunmorl RC700 (trade name, manufactured by Nicca Chemical Co., Ltd.) 2 g/l
                     NaOH in an amount of 2 g/l

Temperature × time   95°C × 30 min

Dyeing a Cellulose Fiber:

Dye: Sumifix Brilliant

Blue R (manufactured by Sumitomo Chemical)

5   Co., Ltd.) 1.0% owf

Bath ratio   1:40

Temperature × time   60°C × 30 min

Dye assistant Na_2SO_4 50 g/l

Na_2CO_3 15 g/l

10   Soaping:

Bath ratio   1:20

Soaping agent   Granup (trade name,

manufactured by Sanyo Chemical

Industries) 1 g/l

15   Water Absorption Treatment:

Bath ratio   1:20

Water absorption treatment agent   SR-1000

(trade name, manufactured by Takamatsu

Yushi K.K.)

20   Final Setting (Creases Being Smoothed Out):

180°C × 0.5 min

(ii) Dyeing Method 2: Dyeing a Polyester Fabric

Scouring

Bath ratio   1:20

25   Temperature × time   80°C × 20 min

Scouring agent   Scourol (trade name,

manufactured by Kao

Corporation) 2 g/l.

Dyeing a Polyester Fiber:

30   Dye: Dianix Blue UN-SE (manufactured by

Dye Star K.K.) 1.0% owf

Bath ratio   1:40

Temperature × time   130°C × 30 min

pH5 buffer CH_3COOH,

35   CH_3COONa

Soaping:
    Bath ratio   1:20
    Soaping agent   Sunmorl RC700 (trade name,
                         manufactured by Nicca
                         Chemical Co., Ltd.) 2 g/l
                         NaOH 2 g/l
    Temperature × time   95°C × 30 min
Water Absorption Treatment:
    Bath ratio   1:20
    Water absorption treatment agent
                SR-1000 (trade name, manufactured by
                Takamatsu Yushi K.K.)
                50% owf
    Temperature × time   95°C × 30 min
Final Setting (Creases Being Smoothed Out):
    180°C × 0.5 min

Example 1

A yarn P prepared by the following procedure was used for a surface layer: a polyester core-sheath composite yarn (75 d/36 f) comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.05% by weight of titanium oxide, and having a weight ratio of the core to the sheath of 1/1 was doubled, and false twisted under the texturing condition 1. A yarn Q prepared by the following procedure was used for a back layer: a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.1% by weight of titanium oxide was doubled, and false twisted under the texturing condition 2. A urakanoko fabric was knitted from the two yarns P, Q with a single knitting machine of 28 GG, and treated by the dyeing method 2 in the dyeing steps explained above. The yarn used as the back layer showed a water absorption value of 2.5 cm and a water diffusion value of 13.1 cm. When the surface form of the knitted fabric was observed by image

analysis, it was found that the resultant fabric was a
two-layered knitted fabric wherein the yarn P occupied
85% of the surface layer, and the yarns P, Q each
occupied 50% of the back layer. The knitted fabric

5   showed a very indistinct color change when wetted. Table
1 summarizes the fabric data (METSUKE, image analysis
results of the surface, a color difference ΔE value and
an organoleptic value of color change), and the yarn data
(method of texturing the yarns P, Q, X and Y values and

10   the titanium oxide contents).

Example 2

A urakanoko fabric was knitted in the same manner as
in Example 1 except that the titanium oxide amount of the
yarns P, Q was varied, and that the yarn Q was changed to

15   a non-texturized cupra yarn. The fabric was evaluated by
the dyeing method 1, and Table 1 summarizes the results.
The back layer showed a water absorption value of 2.0 cm
and a water diffusion value of 8.3 cm. The fabric
obtained in Example 2 showed a very indistinct color

20   change when wetted.

Example 3

A urakanoko fabric was knitted in the same manner as
in Example 1 except that the titanium oxide amount of the
yarns P, Q was varied. Table 1 summarizes the results of

25   evaluating the fabric. The fabric obtained in Example 3
showed a very indistinct color change when wetted.

Example 4

A urakanoko (phonetic) fabric was knitted in the
same manner as in Example 1 except that the titanium

30   oxide amount of the yarns P, Q was varied, and that the
cross-sectional shape of the yarn Q was changed. Table 1
summarizes the results of evaluating the fabric. The
fabric obtained in Example 4 showed a very indistinct
color change when wetted.

35   Example 5

A urakanoko fabric was knitted in the same manner as
in Example 1 except that the titanium oxide amount of the

yarns P, Q was varied, and that a non-texturized raw yarn was used as the yarn Q and the crimping form was changed. Table 1 summarizes the results of evaluating the fabric. The fabric obtained in Example 5 showed a very indistinct

5   color change when wetted.

Example 6

A urakanoko fabric was knitted in the same manner as in Example 1 except that a thick and thin filament yarn (75 d/36 f) having a fiber evenness value U of 3.3% was

10   used as the core-sheath composite fiber forming the yarn P, and that the texturing was conducted under the texturing condition 3. Table 1 summarizes the results of evaluating the fabric. The fabric obtained in Example 6 showed a very indistinct color change when wetted, and

15   further had a very dry feeling and a natural fiber-like appearance.

Example 7

A urakanoko fabric was knitted in the same manner as in Example 1 except that the number of filaments of the

20   W-shaped cross-sectional yarn forming the yarn Q was changed to 75 d/60 f. Table 1 summarizes the results of evaluating the fabric. The fabric obtained in Example 7 showed a very indistinct color change when wetted, and further had a very friendly and soft feeling.

25   Comparative Example 1

A urakanoko fabric was knitted in the same manner as in Example 1 except that the titanium oxide amount of the yarns P, Q was varied. Table 1 summarizes the results of evaluating the fabric. The fabric obtained in

30   Comparative Example 1 showed a distinct color change when wetted.

Comparative Example 2

A urakanoko fabric was knitted in the same manner as in Example 1 except that the titanium oxide amount, the

35   cross-sectional shape and the numbers of the filaments of the yarns P, Q were varied, and that the method of texturing the yarn Q was changed. Table 1 summarizes the

results of evaluating the fabric. The fabric obtained in Comparative Example 2 showed a distinct color change when wetted.

Comparative Examples 3 to 4

Urakanoko fabrics were knitted in the same manner as in Example 1 except that the titanium oxide amount of the yarns P, Q was varied, and that non-texturized rayon was used as the yarn Q. Table 1 summarizes the results of evaluating the fabrics by the dyeing method 1. The fabrics obtained in Comparative Examples 3 to 4 showed a very distinct color change when wetted.

Comparative Examples 5 to 6

Urakanoko fabrics were knitted in the same manner as in Example 1 except that the titanium oxide amount, the cross-sectional shape, and the number of the filaments of the yarns P, Q were varied, and that the method of texturing the yarn Q was changed. Table 1 summarizes the results of evaluating the fabric. The fabrics obtained in Comparative Example 5 to 6 showed a very distinctive color change when wetted.

Comparative Example 7

A urakanoko fabric was knitted in the same manner as in Example 1 except that the titanium oxide amount of the yarns P, Q was varied. Table 1 summarizes the results of evaluating the fabric. Although the fabric obtained in Comparative Example 7 showed a very indistinctive color change when wetted, the fabric showed poor passing of the steps.

Comparative Example 8

A urakanoko fabric was knitted in the same manner as in Example 1 except that the titanium oxide amount, the cross-sectional shape, and the number of the filaments of the yarns P, Q were varied. Table 1 summarizes the results of evaluating the fabric. Although the fabric obtained in Comparative Example 8 showed a very indistinctive color change when wetted, the fabric showed poor passing of the steps.

Example 8

A two-layered plain weave fabric having a warp yarn density of 260/inch, a weft yarn density of 155/inch and METSUKE of 160 g/m^2 was woven with a double weaving loom, using the following warp yarn and weft yarn: a warp yarn comprising (1) a polyester core-sheath composite yarn (50 d/36 f) that comprised a core portion containing 8% by weight of titanium oxide and a sheath portion containing 0.3% by weight of titanium oxide and that had a weight ratio of the core to the sheath of 1/1 and (2) a polyester W-shaped modified cross-sectional yarn (50 d/30 f) that contained 0.1% by weight of titanium oxide; and a weft yarn comprising a core-sheath composite yarn (75 d/36 f) similar to that mentioned above and a W-shaped modified cross-sectional yarn (50 d/30 f) that contained 0.1% by weight of titanium oxide and that was similar to the one mentioned above. The fabric was dyed by the dyeing method 2. As a result of observing the surface of the woven fabric, the fabric was found to have a structure in which the core-sheath composite yarn appeared in the surface layer. The fabric showed a very indistinct color change. Table 1 summarizes the fabric data and the yarn data.

Example 9

A two-layered tuck stitch knit was knitted with a double knitting machine of 28 GG, using the following yarns: a yarn P (used in the surface layer) prepared by false twisting under texturing condition 1 a polyester core-sheath composite yarn (75 d/36 f) that comprised a core portion containing 10% by weight of titanium oxide and a sheath portion containing 0.3% by weight of titanium oxide and that had a weight ratio of the core to the sheath of 1/1; a non-texturized yarn Q (used in the inner layer) that was a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.3% by weight of titanium oxide; and a yarn R (used in the back layer) prepared by false twisting under the texturing

condition 2 a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.3% by weight of titanium oxide. The fabric was dyed by the dyeing method 2. As a result of observing the surface form of the knitted fabric by image analysis, the fabric was found to be a three-layered knitted fabric in which the yarn P occupied 91% of the surface layer. The knitted fabric showed a very indistinct color change when wetted. Table 2 summarizes the fabric data (METSUKE, results of image analyzing the surface, a color difference ΔE value and an organoleptic value of color change) and the yarn data (method of texturing the yarns P, Q and R, X and Y values and the titanium oxide contents).

Example 10

A two-layered tuck stitch knit was knitted in the same manner as in Example 9 except that the titanium oxide amount, the material, the cross-sectional shape and the number of filaments of the yarns P, Q and R were varied. Table 2 summarizes the results of evaluating the fabric by the dyeing method 1. The knitted fabric obtained in Example 10 showed a very indistinct color change when wetted.

Example 11

A two-layered tuck stitch knit was knitted in the same manner as in Example 9 except that the titanium oxide amount, the material, the texturing method and the number of filaments of the yarns P, Q and R were varied. Table 2 summarizes the results of evaluating the fabric by the dyeing method 1. The knitted fabric obtained in Example 11 showed a very indistinct color change when wetted.

Comparative Example 9

A two-layered tuck stitch knit was knitted in the same manner as in Example 9 except that the titanium oxide amount, the texturing method, the number of filaments and the cross-sectional shape of the yarns P, Q and R were varied. Table 2 summarizes the results of

evaluating the fabric in the same manner as in Example 1. The knitted fabric obtained in Comparative Example 9 showed a very distinct color change when wetted.

Example 12

A non-texturized yarn P comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.1% by weight of titanium oxide and having a weight ratio of the core to the sheath of 1/1 was arranged in a front bar. A polyurethane yarn (40 d/3 f) containing no titanium oxide was arranged in a back bar. A non-texturized yarn Q that was a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.1% by weight of titanium oxide was arranged in a middle bar. A 2-way tricot knitted fabric was subsequently knitted with a tricot knitting machine of 28 GG. The knitted fabric was then dyed by the dyeing method 2. As a result of observing the surface form of the knitted fabric by image analysis, the fabric was found to be a three-layered knitted fabric in which the yarn P occupied 98% of the surface layer. The knitted fabric showed a very indistinctive color change when wetted. Table 2 summarizes the fabric data (METSUKE, results of image analyzing the surface, a color difference ΔE value and an organoleptic value of color change) and the yarn data (method of texturing the yarns P, Q, X and Y values and the titanium oxide contents). The fabric was further sewed, so that the W-shaped cross-sectional yarn was to contact the skin, to give spats. The spats had an extremely soft feeling, showed excellent drapability and fitness, and were little wetted when perspiration was produced. The spats were excellent in wearing comfort. The product of the titanium oxide content of the core portion in the yarn P of the tricot knitted fabric and the weft density was 224.

Comparative Examples 10 to 11

A 2-way tricot knitted fabric was knitted in the same manner as in Example 10 except that the titanium

oxide amount, the number of filaments and the cross-sectional shape of the yarns P, Q were varied. Table 2 summarizes the results of evaluating the fabrics thus obtained. Spats were further sewed from these fabrics so

5 that the yarn Q was to contact with the skin side. The product of the titanium oxide content in the core portion of the yarn P and ~~the weft dens~~ity ~~was 8.4 in Comparative Example 11, and 56 in Comparative Example 12~~. The spats had a hard feeling, showed neither good drapability nor

10 good fitting, and were not comfortable.

Example 13

The following yarns were used: a yarn P prepared by false twisting under the texturing condition 1 a polyester core-sheath composite yarn (75 d/36 f)

15 comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.3% by weight of titanium oxide and having a weight ratio of the core to the sheath of 1/1; and a yarn Q prepared by false twisting under the texturing condition 2 a

20 polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 1% by weight of titanium oxide. The yarns P, Q were arranged to form a zigzag lattice, and a 2-course plain knitted fabric (to be knitted in two courses) was knitted in a mixing ratio of 1:1. The

25 fabric was dyed by the dyeing method 2. Fig. 4 shows the knitting diagram of the knitted fabric. As a result of image analyzing the surface of the knitted fabric, the yarn P and yarn Q occupied the surface in proportions of 55% and 45%, respectively. The knitted fabric showed a

30 very indistinctive color change when wetted. Table 3 summarizes the fabric data (METSUKE, image analysis results of the surface, a color difference ΔE value and an organoleptic value of color change) and the yarn data (method of texturing the yarns P and Q, X and Y values

35 and the titanium oxide contents).

Example 14

A 2-course plain knitted fabric was knitted in the

same manner as in Example 13 except that the titanium oxide amount, the number of filaments and the cross-sectional shape of the yarns P, Q were varied. Table 3 summarizes the results of evaluating the knitted fabric.

5   The knitted fabric showed a very indistinct color change when wetted.

     Comparative Example 12

     A 2-course plain knitted fabric was knitted in the same manner as in Example 13 except that the titanium

10   oxide amount, the number of filaments and the cross-sectional shape of the yarns P, Q were varied. Table 3 summarizes the results of evaluating the knitted fabric. The knitted fabric showed a very distinct color change when wetted.

15   Example 15

     The following yarns were used: a yarn P that was a polyester core-sheath composite yarn (75 d/36 f) comprising a core portion that contained 10% by weight of titanium oxide and a sheath portion that contained 0.3%

20   by weight of titanium oxide and having a weight ratio of the core to the sheath of 1/1; and a yarn Q that was a polyester W-shaped modified cross-sectional yarn (50 d/30 f) containing 1% by weight of titanium oxide. The yarns were texturized under the texturing condition 5 to give a

25   double-layered structure yarn having the yarn P as an outer layer and the yarn Q as the core layer. As a result of image analyzing the side surface of the composite yarn, the yarn P and yarn Q were found to occupy the side surface in proportions of 66% and 34%,

30   respectively. A plain knitted fabric was prepared from the composite yarn with a single knitting machine of 28 GG. The knitted fabric was dyed by the dyeing method 2. The knitted fabric showed a very indistinct color change when wetted. Table 5 summarizes the fabric data

35   (METSUKE, image analysis results of the side surface of the yarn, a color difference ΔE value and an organoleptic value of color change), and the yarn data

(method of texturing the yarns P and Q, X and Y values and the titanium oxide contents).

Examples 16 to 17

A plain knitted fabric was knitted in the same manner as in Example 15 except that the titanium oxide amount, the number of filaments, the yarn texturing method and the cross-sectional shape of the yarns P, Q were varied. Table 5 summarizes the results of evaluating the knitted fabrics. The knitted fabrics obtained in Examples 16 to 17 showed a very indistinct color change when wetted.

Example 18

A plain knitted fabric was knitted in the same manner as in Example 15 except that the titanium oxide amount, the number of filaments, the material, the yarn texturing method and the cross-sectional shape of the yarns P, Q were varied. The knitted fabric was dyed by the dying method 1. Table 5 summarizes the results of evaluating the knitted fabric. The knitted fabric obtained in Example 18 showed a very indistinct color change when wetted.

Comparative Example 13

A plain knitted fabric was knitted in the same manner as in Example 15 except that the titanium oxide amount, the yarn texturing method and the number of filaments of the yarns P, Q were varied. Table 5 summarizes the results of evaluating the knitted fabric. The knitted fabric tended to show a distinct color change when wetted.

Example 19

The following yarns were used: a yarn P that was a polyester core-sheath composite yarn (75 d/36 f) comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.3% by weight of titanium oxide and having a weight ratio of the core to the sheath of 1/1; and a yarn Q that was a polyester W-shaped modified cross-sectional yarn (75 d/30

f) containing 1% by weight of titanium oxide. The yarns P, Q were texturized under the texturing condition 12 to give a single layered structure yarn. As a result of image analyzing the side surface of the composite yarn,

5 the yarn P and yarn Q were found to occupy the side surface in proportions of 52% and 48%, respectively. A plain knitted fabric was prepared from the composite yarn with a single knitting machine of 28 GG. The knitted fabric was dyed by the dyeing method 2. The knitted

10 fabric showed a very indistinctive color change when wetted. Table 4 summarizes the fabric data (METSUKE, image analysis results of the side surface of the yarn, a color difference ΔE value and an organoleptic value of color change), and the yarn data (method of texturing the

15 yarns P and Q, X and Y values and the titanium oxide contents).

Comparative Example 14

A plain knitted fabric was knitted in the same manner as in Example 19 except that the titanium oxide

20 amount, the cross-sectional shape, the number of filaments and the yarn compositing method of the yarns P, Q were varied. Table 3 summarizes the results of evaluating the knitted fabric. The knitted fabric tended to show a distinct color change when wetted.

25 Example 20

Using three types of yarns explained below, a double tuck knitted fabric having METSUKE of 133 g/m² was knitted with a double circular knitting machine of 28 GG. A yarn for the surface layer of the fabric was prepared

30 in the following manner: a polyester core-sheath composite yarn (75 d/36 f) comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.05% by weight of titanium oxide and having a weight ratio of the core to the sheath of

35 1/1 was false twisted by an LS-2 manufactured by Mitsubishi Heavy Industries Ltd. at a spindle rotation of 250,000 rpm, a number of twisting of Z-3200 T/M, a first

heater temperature of 190°C and a second heater temperature of 180°C and with a relaxation ratio of 20% to have a crimp stretchability of 20%. The raw yarn of a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.1% by weight of titanium oxide was used for the intermediate layer of the fabric. A yarn for the back layer of the fabric was prepared in the following manner: a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.1% by weight of titanium oxide was false twisted by LS-2 manufactured by Mitsubishi Heavy Industries Ltd. at a spindle rotation of 250,000 rpm, a number of twisting of Z-3200 T/M, a first heater temperature of 190°C and a second heater temperature of 180°C and with a relaxation ratio of 6% to have a crimp strechability of 7%. The fabric was dyed by the dyeing method 2, and evaluated. Table 2 summarizes the results of evaluating the dyed knitted fabric. The water absorption value and the water diffusion value of the yarn for the inner layer were 3.4 cm and 18.2 cm, respectively. The water absorption value and the water diffusion value of the yarn for the back layer were 3.4 cm and 14.5 cm, respectively. The knitted fabric in Example 20 showed a very little color change when wetted, and the wetted fabric did not make one feel that it was wet.

Example 21

Using a yarn P and a yarn Q explained below, a urakanoko fabric having METSUKE of 130 g/m^2 was knitted with a single circular knitting machine of 28 GG. The yarn P to be used for the surface layer of the fabric was prepared in the following manner: a polyester core-sheath composite yarn (75 d/36 f) comprising a core portion that contained 8% by weight of titanium oxide and a sheath portion that contained 0.05% by weight of titanium oxide and having a weight ratio of the core to the sheath of 1/1 was doubled, and false twisted to have a crimp stretchability of 20% by an LS-2 manufactured by

Mitsubishi Heavy Industries Ltd. at a spindle rotation of 250,000 rpm, a number of twisting of Z-3200 T/M, a first heater temperature of 190°C and a second heater temperature of 180°C with a relaxation ratio of 12%. The yarn Q used for the back layer of the fabric was prepared in the following manner: a polyester W-shaped modified cross-sectional yarn (75 d/30 f) containing 0.1% by weight of titanium oxide was doubled, and false twisted to have a crimp stretchability of 7% by an LS-2 manufactured by Mitsubishi Heavy Industries Ltd. at a spindle rotation of 250,000 rpm, a number of twisting of Z-3200 T/M, a first heater temperature of 190°C and a second heater temperature of 180°C with a relaxation ratio of 20%. The fabric was dyed by the dyeing method 2, and evaluated. Table 2 summarizes the results of evaluating the dyed knitted fabric. The knitted fabric in Example 21 showed a very little color change when wetted. The water absorption value and the water diffusion value of the yarn for the back layer were 2.5 cm and 13.1 cm, respectively.

Table 1-1 Two-layered Structure Knitted Fabric

| Ex. | Texture | MET-SUKE g/m² | Covering ratio % | Surface lyer | | | | | | | Method of texturing yarn |
| | | | | Type of yarn | | | TiO₂ conc. % | | | | |
				d/f	Material	Cross section	Core portion	Sheath portion	X	Y	
Ex. 1	Urakanoko	180	85	75/36	Core sheath ester	Round	8	0.05	1.5	7.3	1
Ex. 2	Urakanoko	185	86	75/36	Core sheath ester	Round	10	0.05	1.5	7.3	1
Ex. 3	Urakanoko	183	87	75/36	Ester	Round	2		2.0	4.5	1
Ex. 4	Urakanoko	181	86	75/36	Ester	Round	5		2.0	4.5	1
Ex. 5	Urakanoko	175	85	75/36	Core sheath ester	Round	8	0.1	1.5	7.3	1
Ex. 6	Urakanoko	181	84	75/36	Core sheath thick and thin ester	Round	8	0.05	1.3	6.0	3
Ex. 7	Urakanoko	183	85	75/36	Core sheath ester	Round	8	0.05	1.5	7.3	1
Ex.21	Urakanoko	130	85	75/36	Core sheath ester	Round	8	0.05	1.5	7.3	1
C.E.1	Urakanoko	185	85	75/36	Core sheath ester	Round	2	0.3	1.5	7.3	1
C.E.2	Urakanoko	183	86	75/36	Core sheath ester	Round	5	0.05	1.5	7.3	1
C.E.3	Urakanoko	185	84	75/15	Ester	Round	0.8		0.9	3.9	1
C.E.4	Urakanoko	183	85	75/36	Ester	Round	2		2.0	4.5	1
C.E.5	Urakanoko	178	87	75/36	Ester	Round	2		2.0	4.5	1
C.E.6	Urakanoko	185	85	75/15	Ester	Round	0		0.9	3.9	1
C.E.7	Urakanoko	180	85	75/36	Core sheath ester	Round	16	0.3	1.5	7.3	1
C.E.8	Urakanoko	180	84	75/36	Ester	Round	7		2.0	4.5	1
Ex.8	Backed weave	160	100	Warp 50/36	Core sheath ester	Round	8	0.3	1.9	3.9	Non-texturized
				Weft 75/36	Core sheath ester	Round	8	0.3	1.6	5.7	Non-texturized

Table 1-2 Two-layered Structure Knitted Fabric

Ex.	Texture	d/f	Back layer Type of yarn Material	Cross section	TiO$_2$ conc. %	X	Y	Method of texturing yarn	Δ_E	Organoleptic value
Ex. 1	Urakanoko	75/30	Ester	W	0.1	2.2	4.9	2	3.6	◎
Ex. 2	Urakanoko	75/45	Cupra	Round	1.3	3.9	3.1	Non-texturized	3.1	◎
Ex. 3	Urakanoko	75/30	Ester	W	0.3	2.2	4.9	2	4	◎
Ex. 4	Urakanoko	75/72	Ester	Round	0.1	3.3	4.5	2	3.3	◎
Ex. 5	Urakanoko	75/30	Ester	W	0.8	1.9	5.1	Non-texturized	3.3	◎
Ex. 6	Urakanoko	75/30	Ester	W	0.1	2.2	4.9	2	3.7	◎
Ex. 7	Urakanoko	75/60	Ester	W	0.1	3.1	5.8	2	3.4	◎
Ex.21	Urakanoko	75/30	Ester	W	0.1	2.2	4.9	2	3.6	◎
C.E.1	Urakanoko	75/30	Ester	W	0.3	2.2	4.8	2	6	Δ
C.E.2	Urakanoko	75/15	Ester	Round	0.3	0.9	3.9	1	5.2	Δ
C.E.3	Urakanoko	75/45	Rayon	Round	0	4.0	3.0	Non-texturized	9.4	X
C.E.4	Urakanoko	75/15	Rayon	Round	0.1	3.5	2.0	Non-texturized	6	X
C.E.5	Urakanoko	75/15	Ester	Round	0.7	1.4	5.3	Non-texturized	6.2	X
C.E.6	Urakanoko	75/15	Ester	Round	0.5	0.9	3.9	1	12.1	X
C.E.7	Urakanoko	75/30	Ester	W	0.1	2.2	4.9	2	2.5	◎ ↑
C.E.8	Urakanoko	75/72	Ester	Round	0.1	3.3	4.5	2	2.6	◎ ↑
Ex.8	Backed weave	Warp 50/30	Ester	W	0.3	2.3	4.3	Non-texturized	3	◎ ↑
		Weft 75/30	Ester	W	0.3	1.9	5.1	Non-texturized		

Note: C.E. = Comparative Example

Table 2-1 Three-layered Structure Knitted Fabric

| Ex. | Texture | MET-SUKE g/m² | Covering ratio % | Surface layer | | | | | | | Method of texturing yarn |
| | | | | Type of yarn | | | TiO₂ conc. % | | | | |
				d/f	Material	Cross section	Core portion	Sheath portion	X	Y	
Ex. 9	Double tuck	180	91	75/36	Core sheath ester	Round	10	0.3	1.5	7.3	1
Ex.10	Double tuck	185	90	75/36	Core sheath ester	Round	8	0.05	1.5	7.3	1
Ex.11	Double tuck	198	88	75/36	Ester	Round	3		2.0	4.5	1
Ex.20	Double tuck	133	91	75/36	Core sheath ester	Round	8	0.05	1.5	7.3	1
C.E.9	Double tuck	192	88	75/36	Ester	Round	1.3		2.0	4.5	1
Ex.12	2-Way tricot	180	98	50/36	Core sheath ester	Round	8	0.1	1.9	3.9	Non-texturized
C.E.10	2-Way tricot	183	98	50/36	Core sheath ester	Round	0.1	0.3	1.9	3.9	Non-texturized
C.E.11	2-Way tricot	185	98	50/36	Core sheath ester	Round	0.1	2	1.9	3.9	Non-texturized

Table 2-2 Three-layered Structure Knitted Fabric

| Ex. | Texture | Inner layer | | | | | | Method of texturing yarn |
| | | Type of yarn | | | TiO₂ conc. % | | | |
		d/f	Material	Cross section		X	Y	
Ex. 9	Double tuck	75/30	Ester	W	0.3	0.3	1.9	Non-texturized
Ex.10	Double tuck	75/45	Cupra	Round	1.3	3.9	3.1	Non-texturized
Ex.11	Double tuck	75/30	Ester	W	1	2.2	4.9	2
Ex.20	Double tuck	75/30	Ester	W	0.1	0.3	1.9	Non-texturized
C.E.9	Double tuck	75/15	Ester	Round	0	0.9	3.9	1
Ex.12	2-Way tricot	40d/4f	Spandex	Round	0	/	/	Non-texturized
C.E.10	2-Way tricot	40d/4f	Spandex	Round	0	/	/	Non-texturized
C.E.11	2-Way tricot	40d/4f	Spandex	Round	0	/	/	Non-texturized

Table 2-3 Three-layered Structure Knitted Fabric

Ex.	Texture	ME-TSUKE g/m²	Back layer d/f	Back layer Material	Back layer Cross section	TiO₂ conc. %	X	Y	Method of texturing yarn	ΔE	Organoleptic value
Ex. 9	Double tuck	180	75/30	Ester	W	0.3	2.2	4.9	2	2.8	◎ ↑
Ex.10	Double tuck	185	75/30	Ester	W	0.1	2.2	4.9	2	2	◎ ↑
Ex.11	Double tuck	198	No. 40	Cotton		0	1.6	1.9	Non-texturized	2.6	◎ ↑
Ex.20	Double tuck	133	75/30	Ester	W	0.1	2.2	4.9	2	2.8	◎ ↑
C.E.9	Double tuck	192	75/15	Ester	Round	0.1	0.9	3.9	1	5.6	Δ
Ex.12	2-Way tricot	180	50/30	Ester	W	0.1	2.3	4.3	Non-texturized	2.8	◎ ↑
C.E.10	2-Way tricot	183	50/30	Ester	W	0.3	2.3	4.3	Non-texturized	10.1	X
C.E.11	2-Way tricot	185	50/24	Ester	W	0.1	1.5	6.7	Non-texturized	8.9	X

Note: C.E. = Comparative Example

Table 3-1 Single-layered Knitted Fabric

Ex.	Texture	MET-SUKE g/m²	Covering ratio %	P (White pigment-containing fiber) d/f	P (White pigment-containing fiber) Material	P (White pigment-containing fiber) Cross section	TiO₂ conc. % Core portion	TiO₂ conc. % Sheath portion	X	Y	Method of texturing yarn
Ex.13	2-Course plain knitted fabric	140	55	75/36	Core sheath ester	Round	8	0.3	1.5	7.3	1
Ex.14	2-Course plain knitted fabric	142	56	75/36	Ester	Round	2.5		2.0	4.5	1
C.E.12	2-Course plain knitted fabric	148	50	75/15	Ester	Round	0		0.9	3.9	1

Table 3-2 Single-layered Knitted Fabric

Ex.	Texture	Q (Water-absorbent water-diffusing fiber)							Δ_E	Organo-leptic value
		Type of yarn			TiO$_2$ conc. %	X	Y	Method of textur-ing yarn		
		d/f	Mate-rial	Cross sec-tion						
Ex.13	2-Course plain knitted fabric	75/30	Ester	W	1	2.2	4.9	2	3	◎ ↑
Ex.14	2-Course plain knitted fabric	75/72	Ester	Round	0.3	3.3	4.5	2	3.8	◎
C.E.12	2-Course plain knitted fabric	75/15	Ester	Round	0.1	0.9	3.9	1	11.8	X

Note: C.E. = Comparative Example

Table 4-1 Knitted Fabric with Single-layered Structure Yarn

Ex.	Texture	MET-SUKE g/m^2	Cover-ing ratio %	P (A fiber)						
				Type of yarn			TiO$_2$ concentration %			
				d/f	Material	Cross sec-tion	Core por-tion	Sheath por-tion	X	Y
Ex. 19	Plain knitted fabric	140	52	75/36	Core sheath ester	Round	8	0.3	1.6	5.7
C.E.14	Plain knitted fabric	142	51	75/36	Ester	Round	1		1.8	5.5

Table 4-2 Knitted Fabric with Single-layered Structure Yarn

Ex.	Texture	Q (B fiber)						Compos-iting method	Δ_E	Organo-leptic value
		Type of yarn			TiO$_2$					
		d/f	Mate-rial	Cross sec-tion	Conc.%	e	Y			
Ex. 19	Plain knitted fabric	75/30	Ester	W	0.3	1.9	5.1	12	4.8	◎
C.E.14	Plain knitted fabric	75/15	Ester	Round	0	1.4	5.3	13	6.8	X

Note: C.E. = Comparative Example

Table 5-1 Knitted Fabric with Two-layered Structure
          Yarn

Ex.	Texture	METSUKE	Cover-ing ratio %	Outer layer						
				Type of yarn			TiO₂ conc. %		X	Y
				d/f	Material	Cross sec-tion	Core por-tion	Sheath por-tion		
Ex.15	Plain knitted fabric	140	66	75/36	Core sheath ester	Round	10	0.3	1.5	7.3
Ex.16	Plain knitted fabric	138	74	75/36	Core sheath ester	Round	8	0.1	1.5	7.3
Ex.17	Plain knitted fabric	142	68	75/36	Ester	Round	2		2.0	4.5
Ex.18	Plain knitted fabric	144	75	75/36	Ester	Round	2.5		2.0	4.5
C.E.13	Plain knitted fabric	140	65	75/15	Ester	Round	0		0.9	3.9

Table 5-2 Knitted Fabric with Two-layered Structure
          Yarn

Ex.	Texture	METS-UKE	Core layer				TiO₂ conc. %	X	Y	Method of compos-iting yarn	Δ_E	Organo-leptic value
			Type of yarn									
			d/f	Mate-rial	Cross sec-tion							
Ex.15	Plain knitted fabric	140	50/30	Ester	W		1	3.6	3.7	5	3.6	◎
Ex.16	Plain knitted fabric	138	50/30	Ester	W		0.3	2.3	4.3	4	4	◎
Ex.17	Plain knitted fabric	142	50/72	Ester	Round		0.1	2.0	5.8	8	4.8	◎
Ex.18	Plain knitted fabric	144	50/30	Cupra	Round		1.3	2.3	10.5	4	3	◎ ↑
C.E.13	Plain knitted fabric	140	50/24	Ester	Round		0.1	1.5	6.7	8	13.2	X

Note: C.E. = Comparative Example

Example 22

When the side surface of a union twisted yarn
wherein a highly crimped yarn, that was a white pigment-
containing yarn (75 d/36 f), was used as an outer layer,
and a raw yarn of a water-absorbent and water-diffusing
yarn (50 d/30 f) was used as a core layer was observed,
the white pigment-containing yarn and the water-absorbent
and water-diffusing yarn occupied the side surface in
proportions of 70% and 30%, respectively. The union

twisted yarn was arranged in the surface layer of a warp and weft backed weave, and the raw yarn of a water-absorbent and water-diffusing fiber (125 d) was arranged in the back layer thereof. The white pigment-containing

5 yarn then occupied 70% of the fabric surface, and water-absorbent and water-diffusing fiber occupied 30% thereof.

Example 23

When the side surface of an interlaced false twisted yarn wherein a white pigment-containing yarn (75 d/36 f) was used as an outer layer, and the raw yarn of a water-

10 absorbent and water-diffusing yarn (50 d/30 f) was used as a core layer was observed, the white pigment-containing yarn and the water-absorbent and water-diffusing yarn occupied the side surface in proportions

15 of 60% and 40%, respectively. The yarn and the crimped yarn of a white pigment-containing fiber (125 d) were arranged in the surface layer of a urakanoko fabric in a mixing ratio of 1:1, and the low crimped yarn of a water-absorbent and water-diffusing fiber (150 d) was arranged

20 in the back layer. White pigment-containing fiber then occupied 70% of the fabric surface, and water-absorbent and water-diffusing fiber occupied 30% thereof.

Example 24

A 2-course plain knitted fabric was prepared by

25 arranging in a mixing ratio of 1:1 a yarn obtained by interlaced combining a white pigment-containing yarn (75 d/36 f) and a water-absorbent and water-diffusing yarn (75 d/30 f) without a difference in the yarn length and a crimped yarn of a white pigment-containing yarn (150 d/72

30 f). White pigment-containing fiber occupied 75% of the fabric surface.

Industrial Applicability

Since the composite fabric of the present invention

35 is an anti-color change fabric that does not easily change its color even when the fabric is partially wetted with water, the fabric is suited to a fabric material for

clothing.

The composite fabric of the present invention clearly shows anti-color change properties particularly when the fabric is dyed in a color ranging from a pale color to a color of medium depth. The present invention provides improved knitted or woven fabric materials to the production of outer clothing such as blouses, sports shirts, trousers and long pants that are often exposed to wetting with water such as perspiration and rainwater.